



**MODJAW**  
*Live in motion*

# MANDIBULAR KINEMATICS WITH MODJAW



# PREAMBLE

## Analysis of mandibular kinematics:

MODJAW "Tech in Motion" enables real-time recording as well as an analysis of the mandibular kinematics in the three planes of space.

The methods presented below are illustrating commonly used methods when recording with MODJAW. Practitioners are free to use their own recording methods.

## List of predefined movements to record with MODJAW:

- Protrusion
- Right lateral excursion
- Left lateral excursion
- Opening/Closing
- Centric relation
- Freeway space
- Farrar's diagram
- Gothic arch
- Teeth grinding
- Phonation
- Deglutition
- Mastication
- Sagittal/frontal/horizontal border movements
- Free movements
- Mandibular advancement
- Smile
- Other

## Pre-recording tips:

- Show your patients the movement to perform (you can mimic it with your hands)
- Ask them to practice the movement before recording, to ensure their ability to perform that movement while staying in the camera's field of view (especially when recording opening/closing movements, since it is possible for the SMIL'IT not to be visible by the camera at maximum opening)
- To record, always start from the reference position (MI position defined with the intra-oral scanner)
- For better results, record each movement 2 or 3 times on the same recording sequence (especially for the protrusion and for lateral movements)
- To keep the TIARA and the frontal trackers in place, ask patients not to touch their hair or to move too much

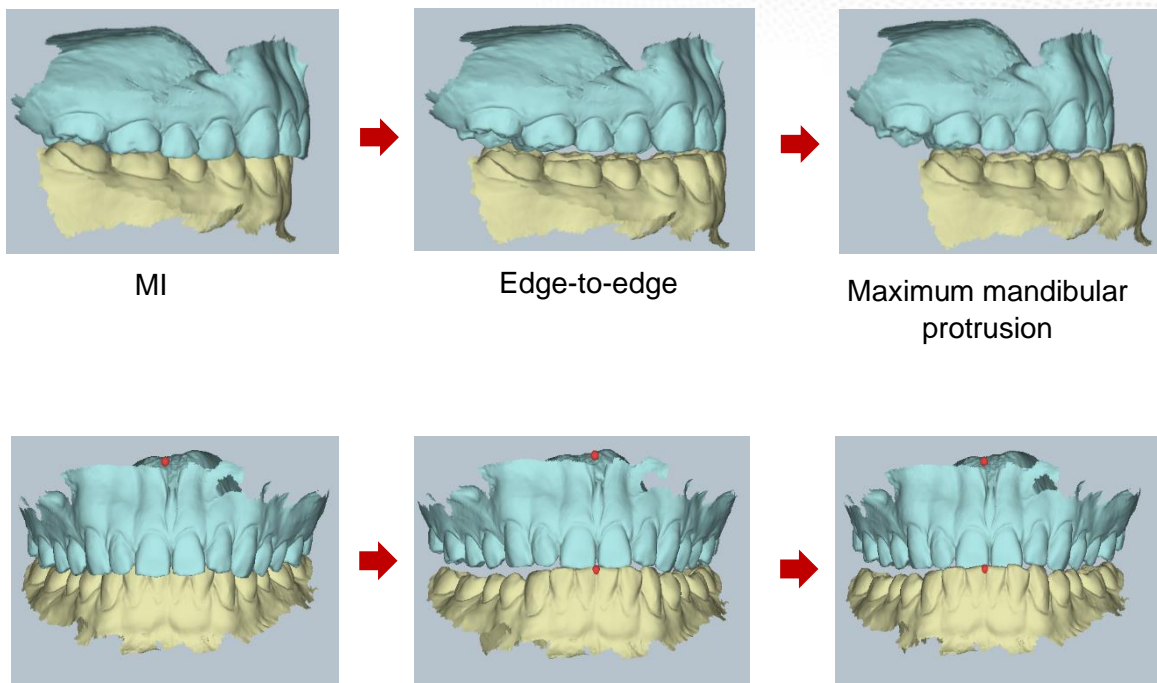
# PROTRUSION

Protrusion is a mandibular movement in a posteroanterior direction across the sagittal plane, allowing a forward shift of the mandible. This movement starts with the MI, and finishes with maximum mandibular protrusion, with or without contacts between teeth. This sagittal movement is usually estimated between 7.3 mm and 9.1 mm (1).

This movement requires both maximum condylar translation and low rotation

At the dental level, the mandibular incisal edges slide along the palatal surface of the maxillary incisors (incisal slope) and reach the “*edge-to-edge*” position, before letting the protrusion continue until reaching the maximum mandibular protrusion.

The opposite movement to protrusion is the mandibular retrusion.

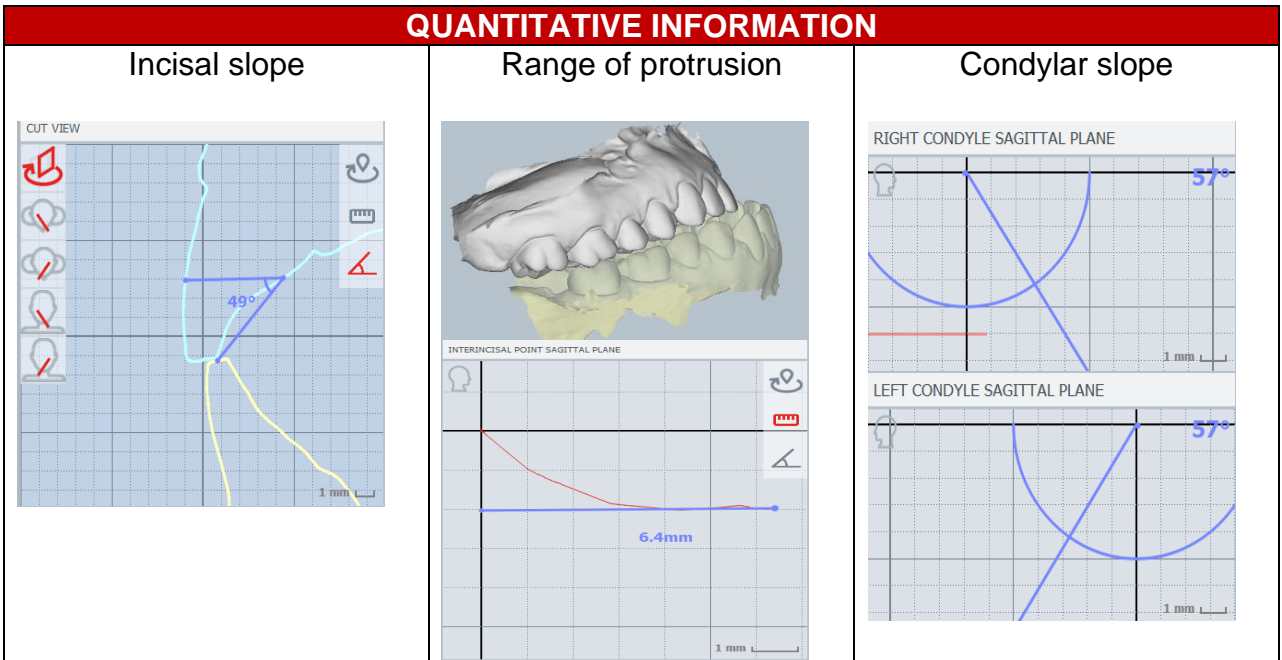
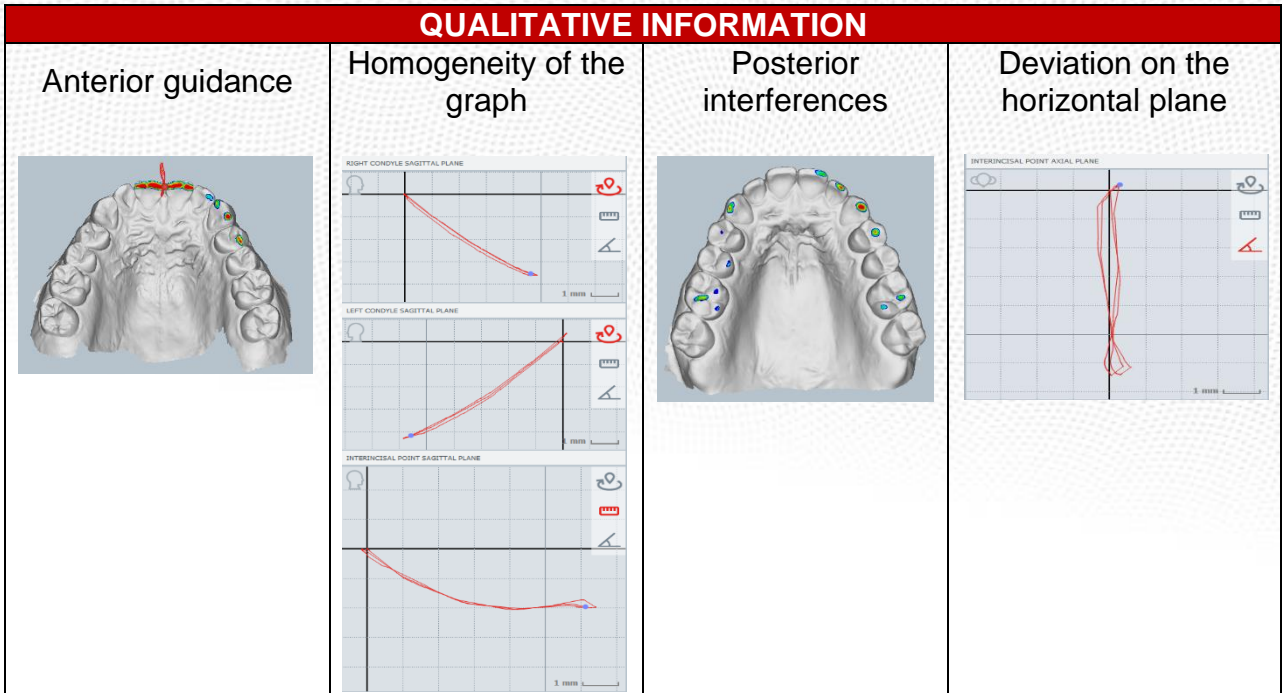


**Clinical case:** occlusal rehabilitation of the entire arch, partial dental prosthesis.

**Movement:** protrusion.

**Technique:** start from the MI reference position, before going to the most anterior position possible. The movement must go through the “*edge-to-edge*” position and the teeth must be kept in contact throughout the whole process (mandibular incisal edges slide along the palatal surface of the maxillary incisors).

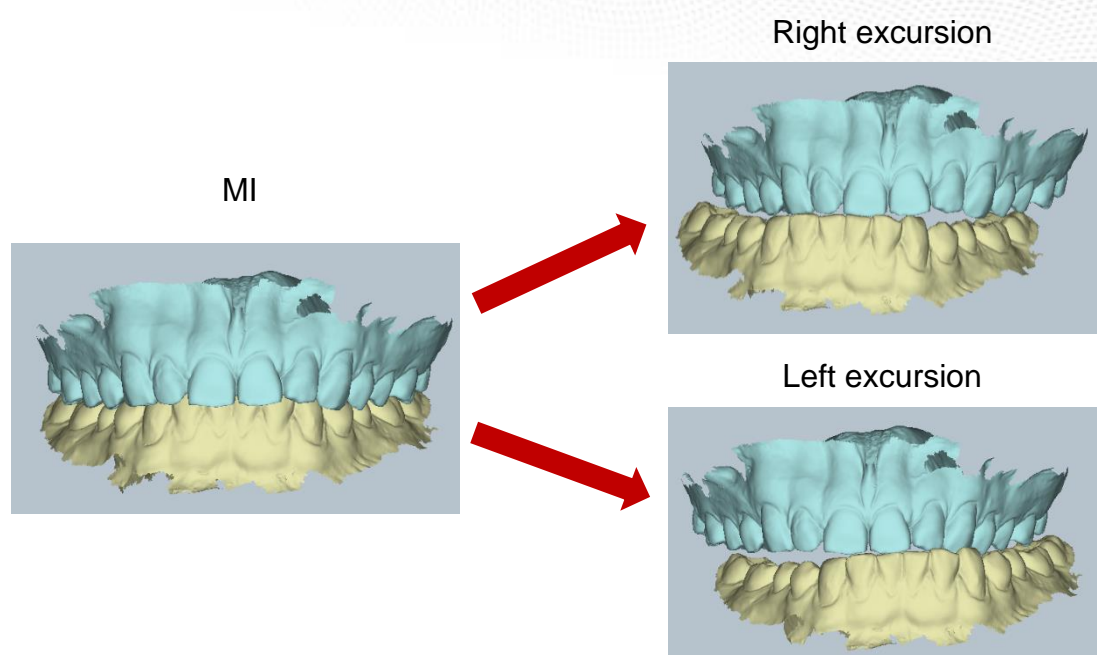
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# LEFT/RIGHT LATERAL EXCURSION:

The lateral excursion is an eccentric, asymmetrical motion of the mandible on the horizontal plane. It corresponds to a succession of movements away from the midsagittal plane (abduction) and towards it (adduction). It can be summarized as the excursion of the mandible on the left and the right.

On the articular level, the condyle located on the opposite side of the movement (non-working side) is called the balancing condyle. On a horizontal plane, this condyle moves downward, forward and inward, forming the Bennett angle with the sagittal plane.

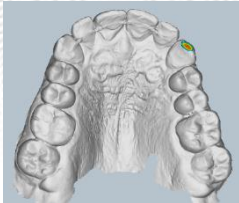
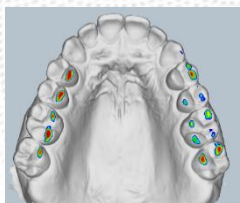
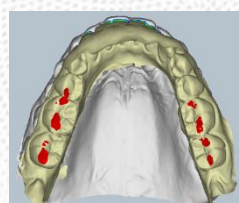
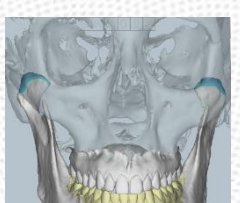
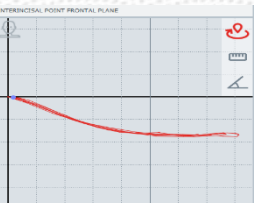


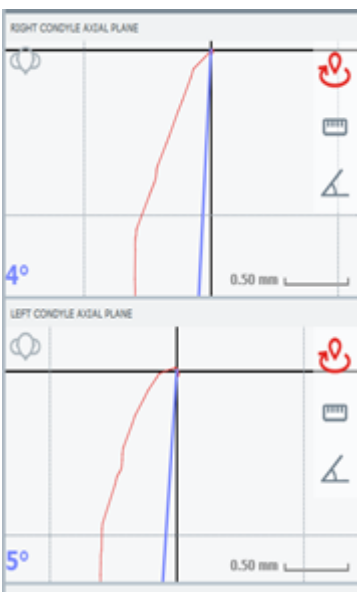

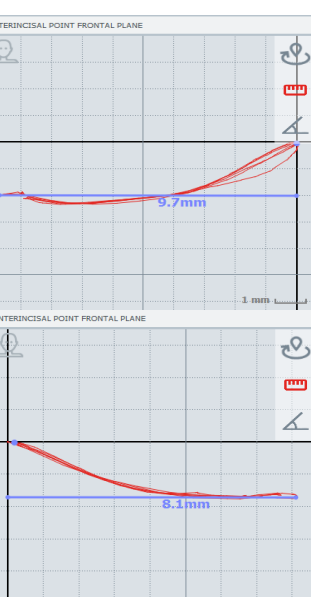
**Clinical case:** occlusal rehabilitation of the entire arch, partial dental prosthesis.

**Movement:** right/left excursion.

**Technique:** start with the MI reference position on the left (or the right) and go to the most lateral position possible, while keeping the teeth in contact.

More (...) →

QUALITATIVE INFORMATION				
<p>Canine guidance</p> 	<p>Group functions + interferences</p> 	<p>Bennet Movement</p> 	<p>TMJ problem</p> 	<p>Homogeneity of the graph</p> 

QUANTITATIVE INFORMATION		
<p>Immediate side shift</p> 	<p>progressive side shift</p> 	<p>Range of motion</p> 

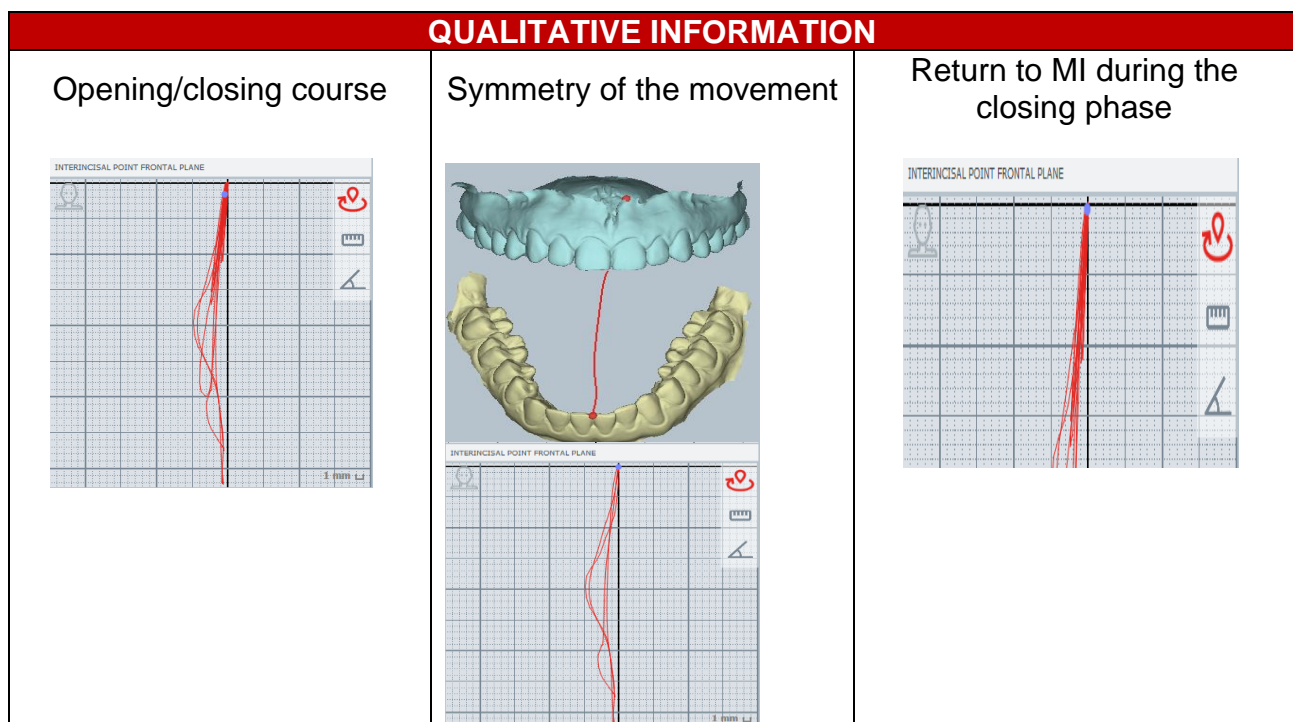
# OPENING/CLOSING:

Opening and closing movements of the mandible are symmetrical movements, ranging between two positions: the MI and the Maximal mouth Opening Capacity (MOC). The average opening amplitude is of 58.2 mm for men and of 54.4 mm for women.

The opening phase is divided into two distinctive parts. First, patients should open their mouth, not too fast, until reaching the MOC. Then, they should open their mouth until reaching a half-open position, before closing it. The patients should repeat this second part several times, at an increasingly faster pace.

**Movement:** opening/closing.

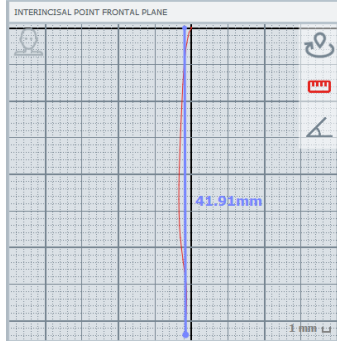
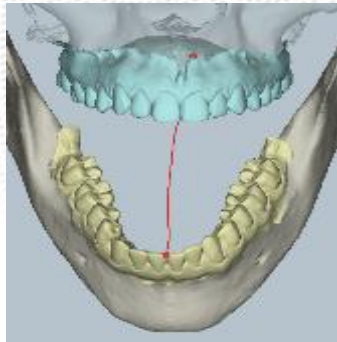
**Technique:** open the mouth slowly until reaching the MOC, before closing it. Repeat this movement twice. Half-open and close. Repeat this movement several times, at an increasingly faster pace.



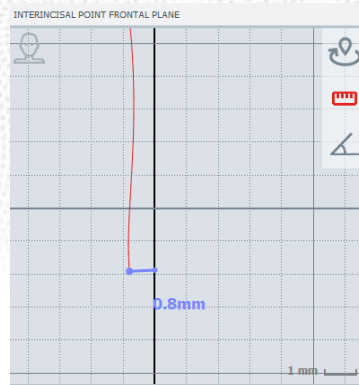
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## QUANTITATIVE INFORMATION

Amplitude of opening



Measure of the deviation (if the movement is not symmetrical)





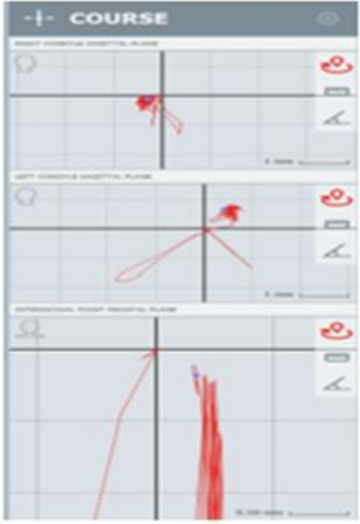
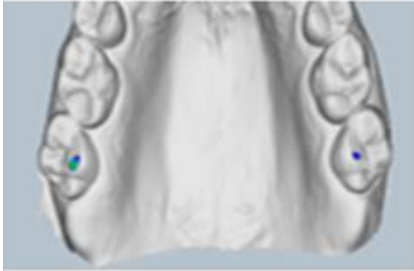
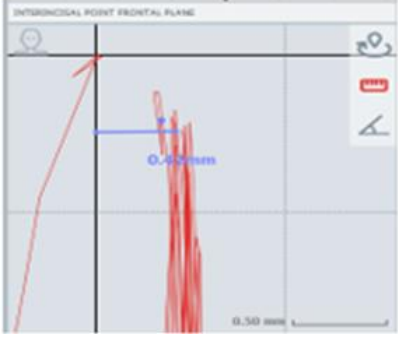
# CENTRIC RELATION (CR):

The centric relation is an articular reference position. It is a key element of clinical practice since it is essential to work with a physiological reference position which is independent from the teeth. It is particularly important when working with a pathological, incomplete or absent denture, or when we are trying to evaluate it.

Centric Relation (CR) is a maxillomandibular relationship, independent of tooth contact, in which the condyles articulate in the anterior-superior position against the posterior slopes of the articular eminences; in this position, the mandible is restricted to a purely rotary movement; from this unstrained, physiologic, maxillomandibular relationship, the patient can make vertical, lateral or protrusive movements; it is a clinically useful, repeatable reference position. (The *Glossary of Prosthodontic Terms*: Ninth Edition)

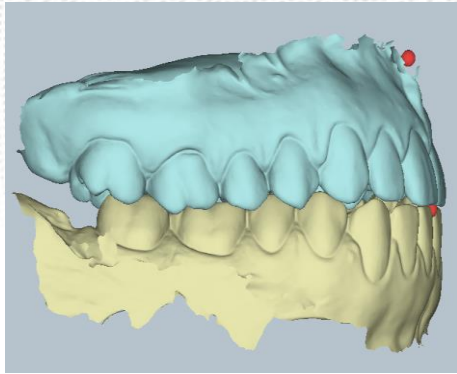
**Movement:** CR.

**Technique:** from the MI reference position of the patient at rest, ask the patient to open the mouth. From that position, the patient must perform repeated upward movements (guided by the practitioner), looking for the first dental contact. This guiding can also be performed with a Jig, a silicon key, TENS, etc.

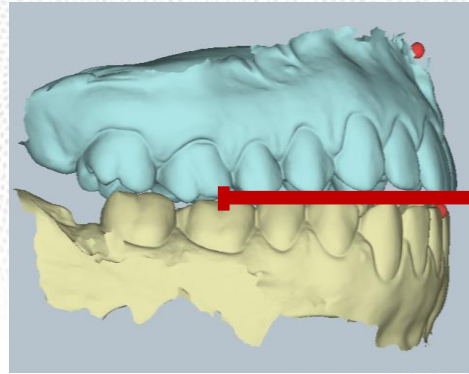
QUALITATIVE INFORMATION		QUANTITATIVE INFORMATION
<p>Coincidence between CR and MI</p> 	<p>Search for first contact between teeth (the interference)</p> 	<p>Calculation of the offset between CR and MI in the sagittal direction</p> 

# FREEWAY SPACE (FWS):

It represents the space between the occlusal surface of the posterior teeth at rest. To measure it, you need to calculate the difference between the Rest Vertical Dimension (RVD) and the Occlusal Vertical Dimension (OVD). This space is essential for the neuromuscular equilibrium of the stomatognathic system, which guarantees good orofacial functions. (2)



**MI**



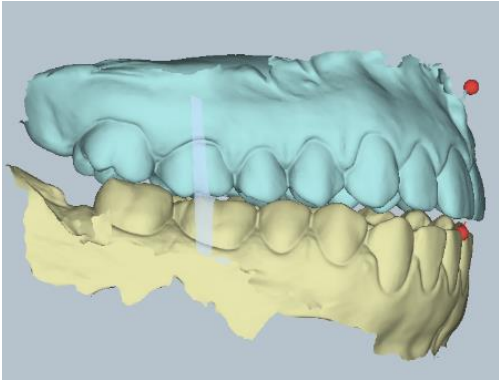
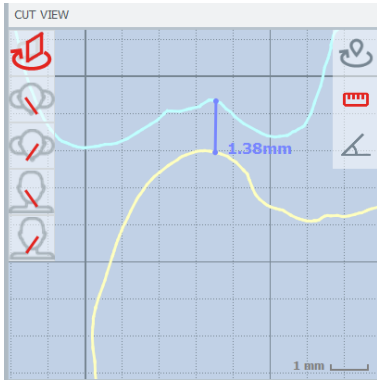
**Rest position**

**Clinical case:** disruption of the Vertical Dimension.

**Movement:** FWS.

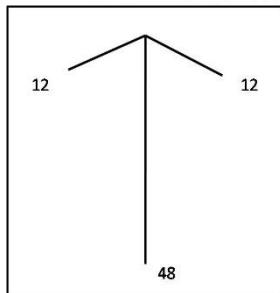
**Technique:** practitioners each have their own way of recording the FWS.

ex. By making the patient pronounce the word “MAMA” before going back to a rest position, by making the patient swallow water before going back to a rest position, etc.

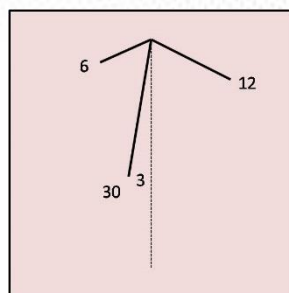
QUALITATIVE INFORMATION	QUANTITATIVE INFORMATION
<p>Make sure to respect this space in the case of a full prosthetic rehabilitation</p> 	<p>Calculation of the Freeway Space and estimation of an adequate OVD</p> 

# FARRAR'S DIAGRAM (FD):

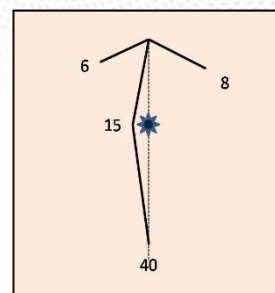
The Farrar's diagram is a simplified graphic representation of the movements of the mandibular interincisal point. Opening/closing and lateral movements are recorded starting from the MI and on the frontal plane. It therefore represents mandibular movements on the frontal plane by a vertical arrow. This diagram contributes to a better precision for the diagnosis of Temporomandibular Disorders (TMD). (3)



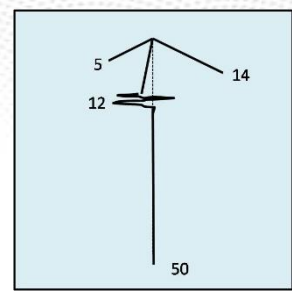
Normal FD



Disc displacement without reduction and limitation of movement



Disc displacement with reduction and joint noise (clicking joint)



Disc displacement with reduction and with particularities

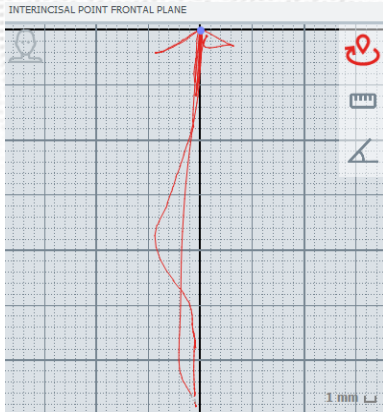
**Movement:** Farrar's diagram.

**Technique:** from the MI, patients should open their mouth until reaching the MOC, then close it, and proceed by performing right then left lateral excursions. They should then go back to the MI.

More (...) →

## QUALITATIVE INFORMATION

Course (deflection or deviation) when opening/closing. Symmetry of the angulation of the course (between right and left lateral excursion)

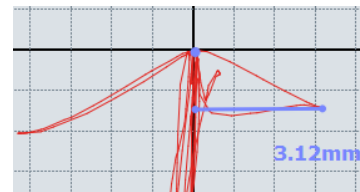
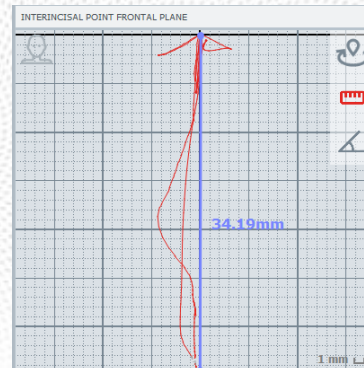


TMJ disorders (joint noise, joint pain, joint locking)

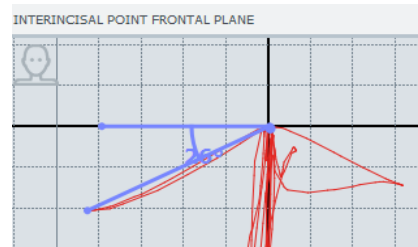
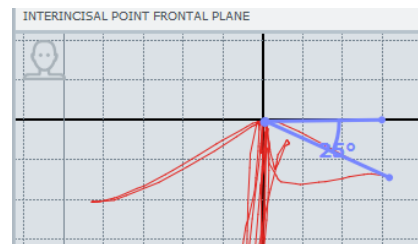


## QUANTITATIVE INFORMATION

Range of motion



Angular difference between left and right

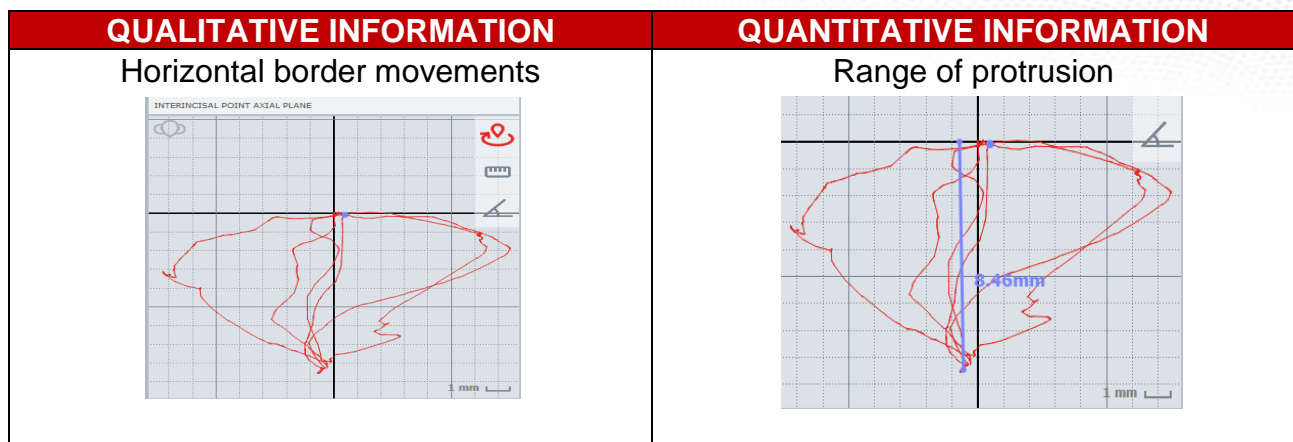


# GOTHIC ARCH:

Recording made on the horizontal plane. The graph displays the movement of the interincisal point during protrusion combined with left then right lateral excursion, before the patient comes back to the CR.

**Movement:** gothic arch.

**Technique:** ask your patient to perform a protrusion movement, then to return to the MI, before performing (right and left) excursion movements by going to the maximal protrusion position.



# TEETH GRINDING:

Teeth grinding or bruxism defines any “empty” screeching or clenching of the teeth (outside of the mastication and deglutition phases). Consequences are mild if the phenomenon stays rare, but damages can be irreversible if it becomes persistent.



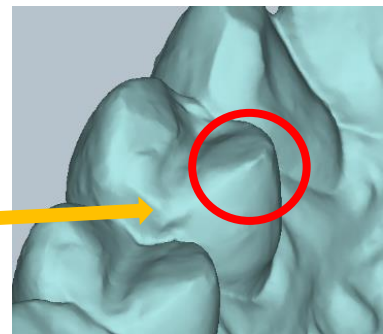
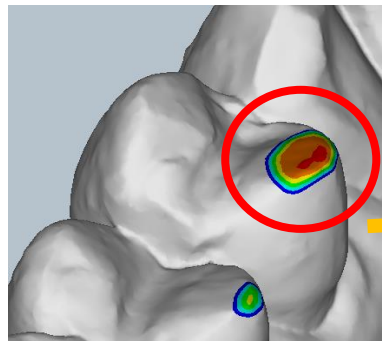
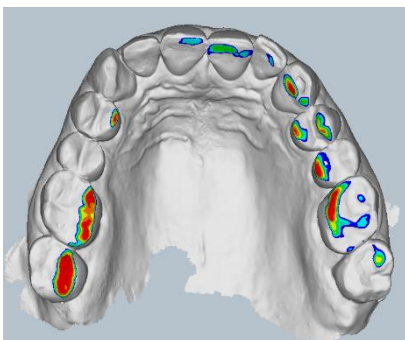
**Clinical case:** important erosion of the teeth and loss of the VD.

**Movement:** grinding.

**Technique:** ask patients to clench their teeth. They should then try to grind their teeth.

## QUALITATIVE INFORMATION

Check if the wear of the teeth is caused by bruxism or by chemical wear



# PHONATION:

Phonation is a communicative function.

Several anatomical units (glottis, pharyngeal cavities, tongue and teeth) play a role in phonation, turning it into an articulated language made of phonemes.

Oral effectors come into play in the supraglottic zone.

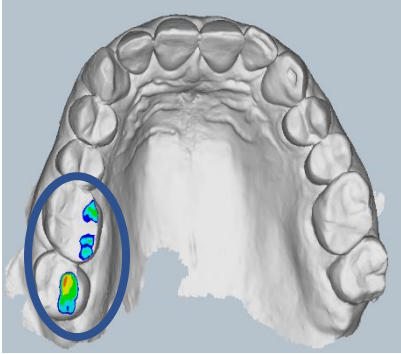
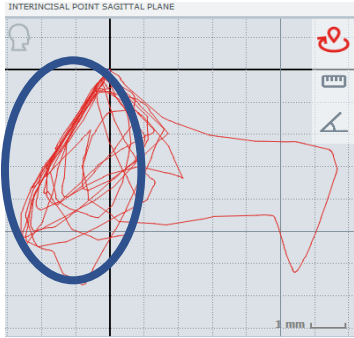
As for diagnosis, the practitioner must analyze phonation by hearing and sight (with the information displayed on MODJAW during the exam).

It is important to note that an atypical deglutition often comes with an impaired phonation. Phonation impairment often alters late-acquired consonants in children (J/S/Z/SH, but also D/T/N/L).

**Clinical case:** impaired phonation.

**Movement:** phonation.

**Technique:** ask the patient to count from 60 to 70, from the MI reference position.

QUALITATIVE INFORMATION	QUANTITATIVE INFORMATION
<p>Interferences during phonation Confirm some dental anomalies caused by an impaired phonation</p> 	<p>Measure of the anterior area of function during phonation (extremely important – please respect it during the design in order not to disrupt phonation)</p> 

# DEGLUTITION:

Deglutition is a voluntary reflex allowing the alimentary bolus (after mastication) and the saliva to pass through the digestive tract.

It usually lasts one second, and its frequency ranges from 500 to 1500 times a day.

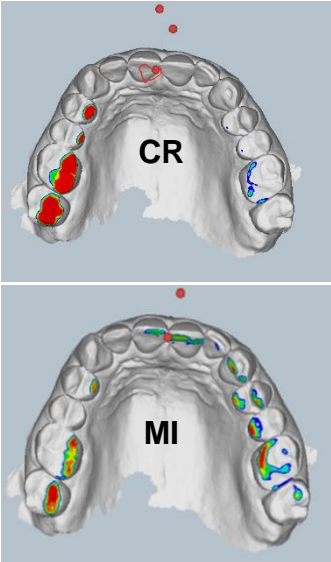
Deglutition comprises three phases: the oral phase (the only voluntary one), the pharyngeal phase, and the esophageal phase. MODJAW analyzes the oral phase.

Physiologically, in adults, deglutition is made with clenched teeth (in the MI position), lips sealed without interposition of the tongue between arches. The tongue (tip behind the maxillary incisors) rises towards the palate to thrust the alimentary bolus in the esophagus.

**Clinical case:** impairment of the Vertical Dimension.

**Movement:** deglutition.

**Technique:** use a small syringe filled with water. Ask the patient to swallow.

QUALITATIVE INFORMATION	QUANTITATIVE INFORMATION
<p data-bbox="177 824 769 891">Check if deglutition is done while in CR or in MI</p> 	<p data-bbox="831 860 1406 927">Evaluate the difference between CR and MI</p> <p data-bbox="991 972 1246 1005">Evaluate the OVD</p>



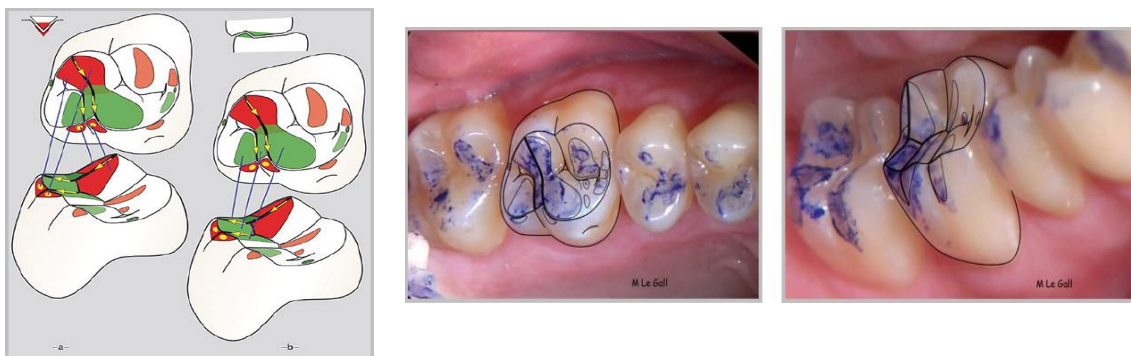
# MASTICATION:

It can be defined as the motor behavior allowing the fractioning and the insalivation of food. It represents the first step of both nutrition and digestion. The following elements come into play during mastication:

- Teeth (occlusion)
- Muscles
- TMJ

Mastication starts with voluntary movements before becoming semi-automatic. It consists in the mastication and modification of food consistency to ease deglutition. Repetitive movements are performed, starting from the MI, and going back to it. These movements represent the cycles of mastication.

Physiologically, mastication is performed unilaterally by alternating between the right side and the left side.



It is **essential** to include mastication in your diagnostic and therapeutic approaches.

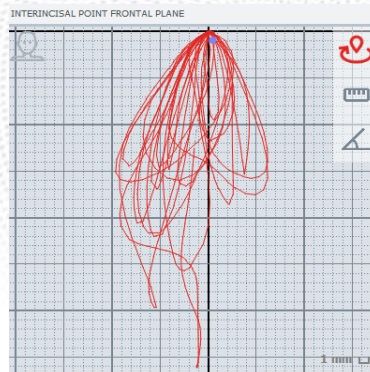
**Movement:** mastication.

**Technique:** ask the patient to perform an “empty” simulation. Then, the patient should chew on 40 µm articulating paper, by putting it on the right, then on the left. In the end, introduce food (a small piece of apple, with the peel, of approximately 1 cm<sup>3</sup>). Both the chewy part (pulp) and the crispy part (peel) are needed to have a complete cycle of mastication. Avoid using chewing-gum, as it may displace the fork.

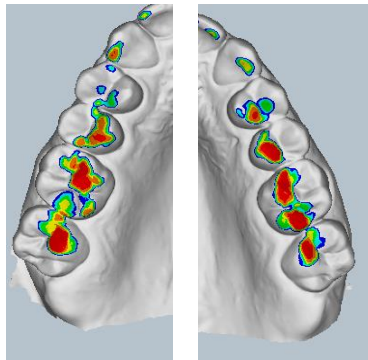
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## QUALITATIVE INFORMATION

Check the symmetry when coming back to the MI on both sides



Shape of the cycles (entry/exit contacts of the mastication cycles)

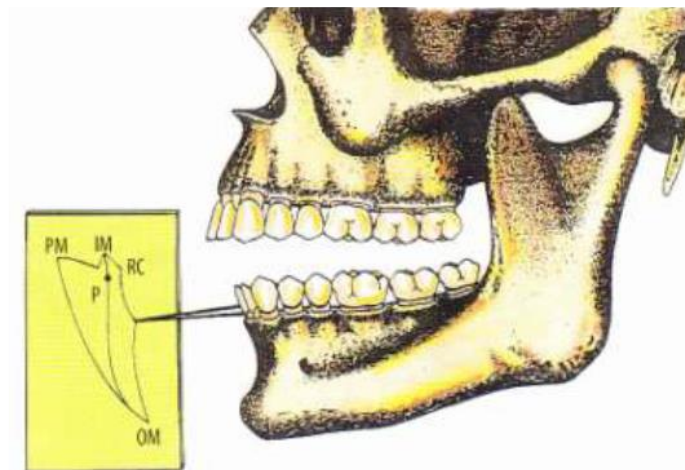


# BORDER MOVEMENTS ON THE SAGITTAL, FRONTAL AND HORIZONTAL PLANES:

## In the sagittal plane: POSSELT diagram

The study of the maximum range of motion of the mandibular interincisal point during the different movements lets us define the limit envelope of mandibular movements.

Ulf Posselt (1951) studied movements of the interincisal point on the midsagittal plane; the diagram then obtained is valid for any point of the mandible (condyles as well as incisors).



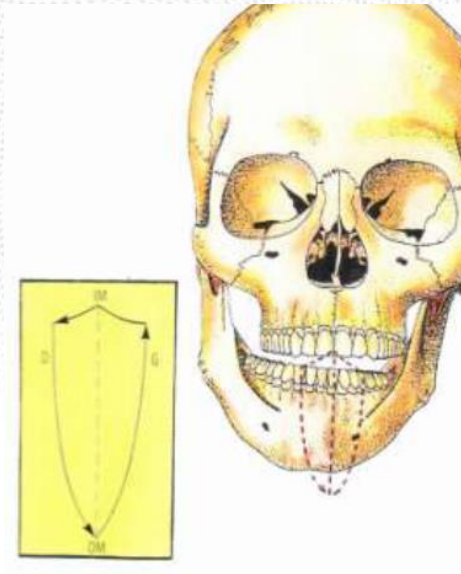
## In the frontal plane:

From the MI (or CR), the mandible follows the midsagittal plane downward to reach the MOC.

From that point, the mandible moves laterally to the right and the left during excursion movements.

If the mandible is lowered from a lateral position, a curved movement ending on the MOC (and vice-versa) is performed.

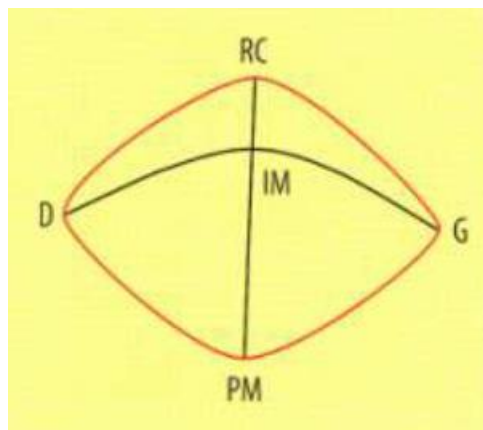
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## In the horizontal plane:

From the MI (or CR), the mandible follows the mid-horizontal plane towards the front, to reach the maximal protrusion position.

From that point, the mandible moves laterally to the right and the left during excursion movements, before coming back to the starting position.





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**THANK YOU**

